July 7, 1936. C. E. REED 2,047,114

COMBINED DISK AND ROLLER BIT

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FIG. 1.

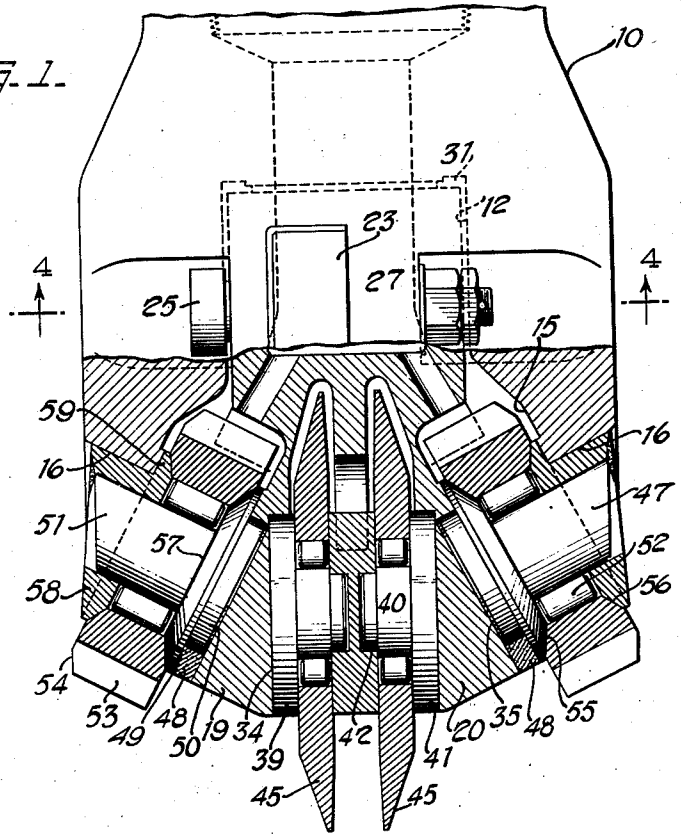

FIG. 2.

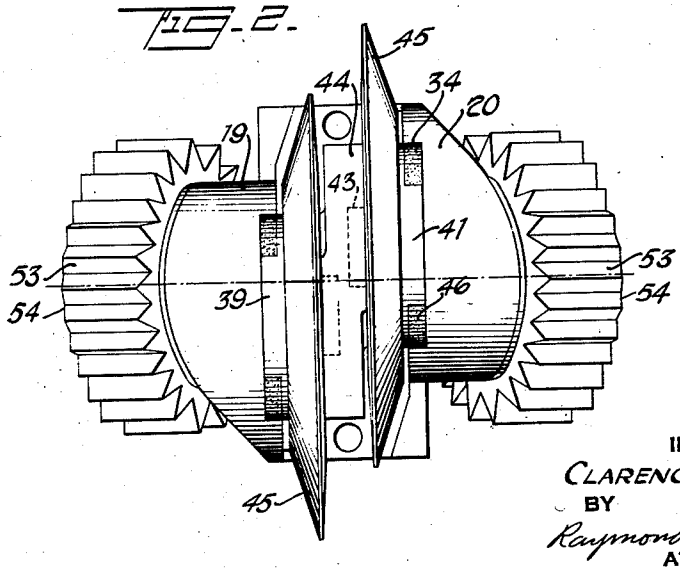

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FIG. 3.

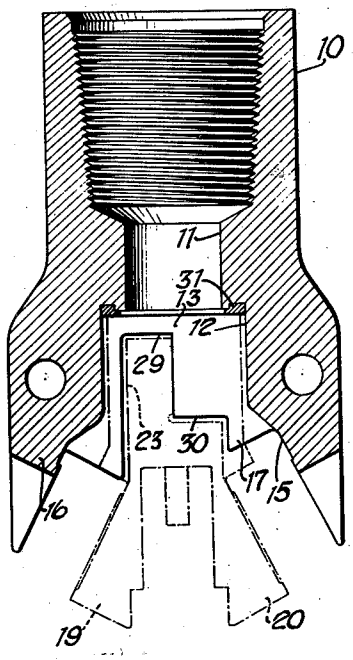

FIG. 4.

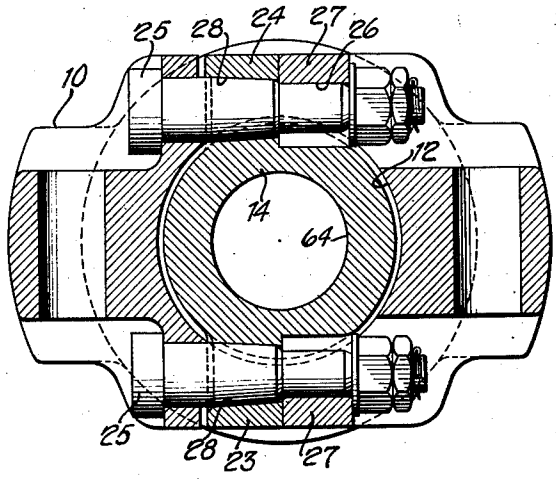

FIG. 5.

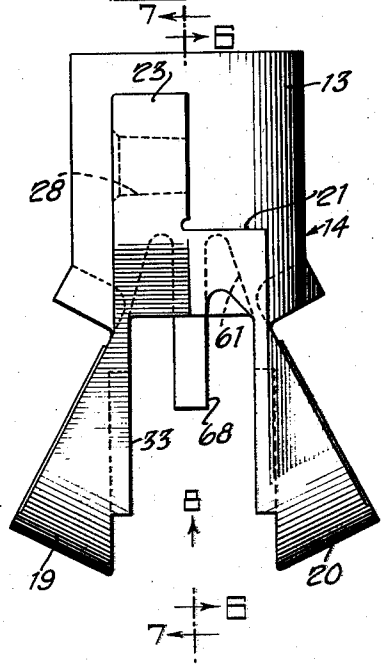

FIG. 6.

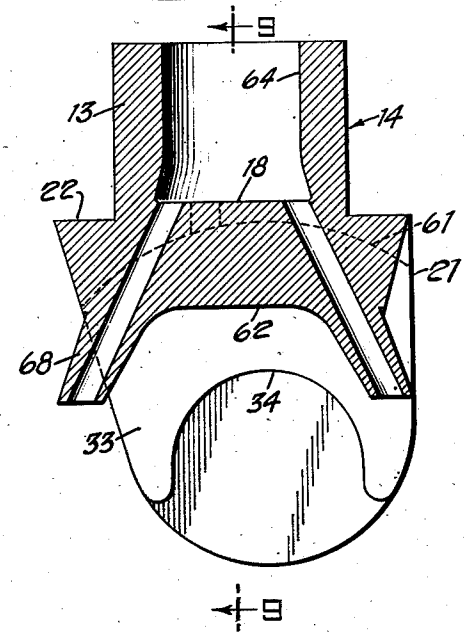

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FIG. 7.

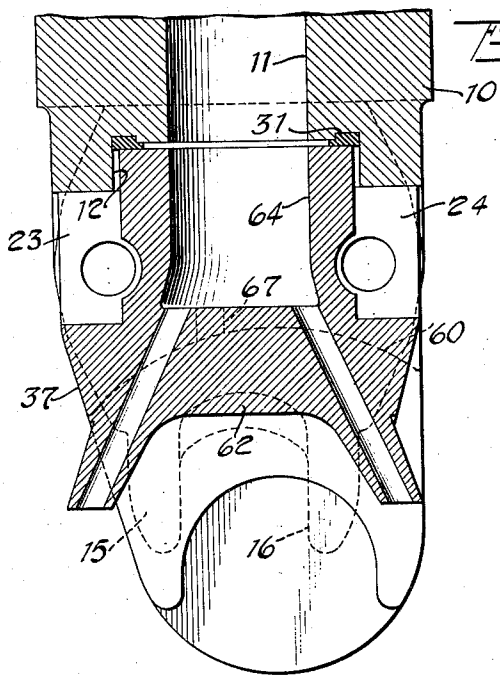


FIG. 8.

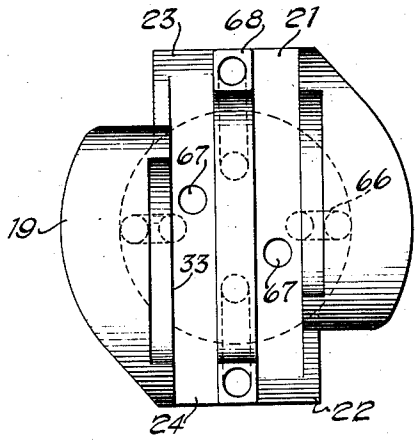


FIG. 10.

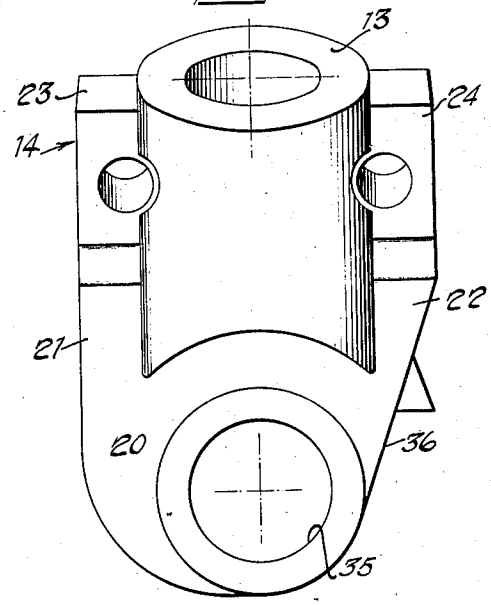
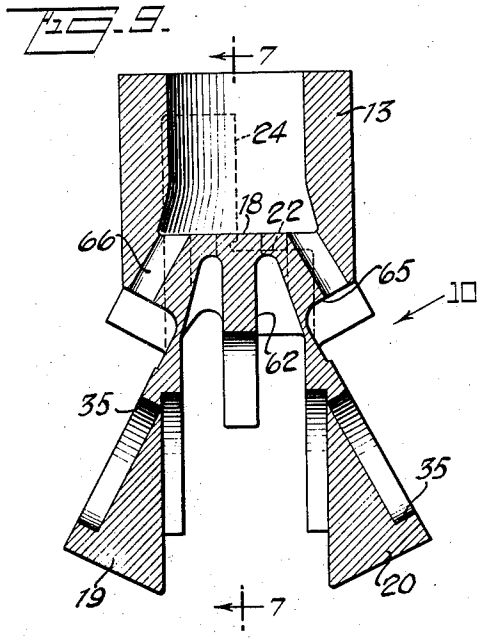


FIG. 9.



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Patented July 7, 1936 2,047,114

UNITED STATES PATENT OFFICE

2,047,114

COMBINED DISK AND ROLLER BIT

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Application May 16, 1933, Serial No. 671,325

22 Claims. (Cl. 255—71)

This invention relates to earth boring apparatus and more particularly to a drill bit having improvements relating to disk cutters, roller cutters, and to a combination of both types of cutters.

For drilling in comparatively soft earth formations, disk cutters embody the advantage of more rapid penetration than the conventional roller cutters, while the latter are generally more satisfactory for harder formations since they tend to pulverize harder material. It has been found that the penetration of disk cutters can be increased by employing them in combination with roller cutters adapted to cut an annular area surrounding the area cut by the disks. In such an arrangement the roller cutters maintain the gauge of the hole and relieve a considerable portion of the wear on the disks, thereby prolonging their life. However, owing to the space taken up by the roller cutters, the problem presents itself of providing proper support for the disks and rollers which will withstand the heavy thrusts to which the cutters are subjected. Accordingly, it is an object of this invention to provide a cutter unit upon which roller and disk cutters are mounted and supported against heavy thrusts.

Another object of this invention is to provide a bit having means for supporting disk or similar cutters against movement in the direction of their axes. In accordance with this object each disk is mounted upon a spindle having a portion engaging one face of the disk. The other face of the disk is held against lateral movement by a disk spacer member separating two disks.

A further object of this invention is the provision of a combined disk and roller bit in which all the cutters are mounted upon a carrier member adapted to be inserted as a unit into a bit head. This object is obtained by providing the carrier with two spindle supporting portions defining a substantially central recess in which the disk cutters are mounted. The spindles for supporting the roller cutters are mounted on the outside of the spindle supporting portions. A feature of this carrier member resides in the shape of the supporting portions which permits the disk cutters to be supported with their axes offset while the roller cutters have axes in the same transverse vertical plane as the bit axis.

A still further object of the invention is to provide an arrangement of cutting disks, cutter spindles and a spacer member between the disks, which arrangement is adapted to be inserted as a unit into a carrier member. Inasmuch as the spindles which support the disks are movable laterally into the carrier member, they do not interfere with the roller cutters on the outside surface of the carrier.

Another feature of this invention resides in an arrangement for delivering flushing fluid to the cutters and to the bottom of the hole in proximity to the cutters.

Still another object of the invention is to provide a bit of the character described in which any or all of the cutters may be conveniently replaced.

Other objects and features of the invention will appear more clearly from the following description taken in connection with the accompanying drawings and appended claims. In said drawings:

Fig. 1 is a view partly in elevation and partly in section of a portion of a bit head having cutters embodying the present invention;

Fig. 2 is a bottom view of the bit shown in Fig. 1;

Fig. 3 is a cross-sectional view of the bit head looking in the same direction as Fig. 1 but drawn to a smaller scale and showing the carrier member in broken lines;

Fig. 4 is a cross-section of the bit head and carrier member looking in the direction of the arrows 4—4, Fig. 1;

Fig. 5 is a side elevation of the carrier member;

Fig. 6 is a central section of the carrier member looking in the direction of the arrows 6—6 of Fig. 5;

Fig. 7 is a section in the same plane as Fig. 6 but looking in the opposite direction and showing the bit head as well as the carrier member;

Fig. 8 is a bottom view of the carrier member;

Fig. 9 is a central section of the carrier member looking in the direction of the arrows 9—9, Fig. 6; and

Fig. 10 is an isometric view of the carrier member looking in the direction of the arrow 10, Fig. 9.

Referring to Figs. 1, 3, 4 and 7, the bit head is shown at 10 having an internally threaded upper end for attachment to the drill pipe. It has a central bore 11 for the downward passage of flushing fluid. It has a recess or counterbore 12 in its lower end of substantially cylindrical form to receive the upper cylindrical end 13 of the carrier member 14 of the cutter unit. Below the counterbore 12 the recess flares outwardly and downwardly, the inclined walls of this flaring recess being indicated at 15. The depending walls 15 have downwardly open notches or bear-

ing seats 16 at their lower ends. The notches 16 are in line with each other or, in other words, their centers lie in the same vertical plane passing through the axis of the bit head from end to end thereof. The lower portion of the recess defined by the walls 15 is open laterally of the bit head, while the upper portion of said recess is partially confined by the lateral walls 17 (Fig. 3). These walls are cut away in stepped formation to receive the correspondingly shaped portions of the carrier member to be described presently. It will be noted from Fig. 4 that the bit head is longer than it is wide thereby providing a space between the lateral walls 17 and the side of the bore hole to permit the free upward passage of flushing fluid and cuttings.

At its lower end the cylindrical portion 13 of the carrier member is joined to a body portion 18 from which depend two spindle supporting portions 19 and 20. Enlargements 21 and 22 at the sides of the bit reinforce the connection between the spindle portion 20 and the body. Lugs, arms, or wings 23 and 24 project upwardly from similar enlargements for the portion 19 and serve as means for supporting the carrier member in the bit head. These lugs and enlargements are received within the recesses in the walls 17 as shown in Fig. 3. The cutter unit is held to the bit head by tapered bolts 25 passing through openings 26 in projections 27 of the bit head on its lateral walls and through openings 28 in the lugs 23 and 24 of the carrier member, which lugs, when the parts are assembled, lie alongside the parts 27 of the bit head (see Fig. 1). The upper ends of the lugs and enlargements on the cutter unit do not bear upon the shoulders 29 and 30 on the lateral walls 17 of the bit head. The upthrust is taken by the bolts 25 and the bit head. Upthrust is also taken by the central cylindrical portion 13 of the cutter unit which, as shown in Fig. 3, at its upper end bears upon the packing ring 31 seated in the bit head.

The spindle supporting portions 19 and 20 of the carrier member are complementary to each other and are spaced to provide a central recess 33. The side walls of this recess are recessed further to provide seats 34 for supporting the disk bit unit as will be described presently. These seat recesses are offset from each other in order that the axes of the discs may be mounted in offset relation near the center of the hole. As seen in Fig. 8, the portions 19 and 20 are irregular or eccentric in shape, their lower ends being oppositely offset along the edge of the central recess 33, while the peripheral faces of the two supporting portions 19 and 20 have bearing surfaces in line with each other and with the axis of the bit. As seen in Fig. 10, one of the enlargements 21, which reinforces the neck connecting the supporting portion 20 to the body 18 of the carrier, is vertical, while the enlargement 22 has an inclined edge 36. A converse arrangement is presented in the case of supporting portion 19, which is offset in the opposite direction and joined to the lug 24 along a vertical line and to the lug 23 along an inclined edge 37 (see Fig. 7).

The seat recesses 34 receive disk bearing members 39. Each of these bearing members comprises a spindle portion 40, a flange 41, and a projection 42. The projections 42 are received within sockets 43 formed in a spacer member 44. The projections 42 and sockets 43 are offset similarly to the seat recesses 34 (see Fig. 2). Disk cutters 45 are mounted upon the respective spindles 40 between the disk spacer 44 and the flanges 41. Roller bearings may be interposed between the disk cutter and its associated bearing, if desired. It will be noted that the side faces of the disks are held against any axial movement by the spacer 44 and flanges 41 respectively. This is an important feature of the invention since it prevents the disk cutters from rocking or shifting their axes in response to lateral thrusts at the bottom of the hole which would ordinarily confine the cutters against rotation and cause excessive wear on both the peripheral and inside surfaces of the cutters as well as on the bearings.

The disk cutter assembly is removable from and insertable into the carrier 14 as a unit. In assembly, the disks are mounted upon their respective spindles 40, and the latter are then inserted loosely into the sockets 43 on the spacer. The assembly of cutters, spindles, and spacer is then inserted as a unit into the cutter recess 33, the flanges or thrust receiving portions 41 being seated into the seat recesses 34. The entire disk cutter assembly may then be welded in place, as indicated at 46, Fig. 2. The parts will then be in the position shown in Fig. 1, the spacer member being held against rotation on its axis owing to the eccentric recesses 43. To remove the disk cutter assembly, the weld 46 is first broken and then the assembling process is reversed. It will be noted that the disk assembly may be both inserted and removed without disturbing or causing the removal of the roller cutters.

The roller cutter assembly is similar in many respects to the roller cutter unit shown in applicant's prior application, Serial No. 646,628, filed December 10, 1932. It comprises cutter spindles 47 supported by and seated in the sockets 35. The spindles are arranged in such relation as to form substantially an inverted arch-shaped structure. The two spindles may be welded to the carrier member 14, as indicated at 48 (Fig. 1). Each of the spindles 47 is provided with a flange 49 which abuts the spindle supporting member 19 (or 20) around the edge of the socket 35, and with a cylindrical extension 50 which is received by said socket. The flange 49, extension 50 and bearing portion 51 of the spindle are preferably integral, but it will be understood that they may be formed of separate parts rigidly united to each other, if desired. Surrounding the spindles 47 are roller bearings 52 upon which are mounted the roller cutters 53.

Each of the cutters 53 is provided on its peripheral surface with cutting teeth, the outer edges 54 of which are bevelled. The inside diameter of the cutter is bevelled at the edges 55 and 56 to cooperate with their associated bearing surfaces to resist the lateral and vertical thrusts imposed upon the cutter. Cooperating with the edge 55 on the cutter is the bevelled part of the surface on the flange 49. The lowermost part of flange 49 engages the cutter edge 55 over a limited area in substantially a vertical plane, the area of engagement being approximately at the same level as the point where the edge 54 engages the side of the bore hole. As a result of the arrangement just described, the radial pressure of the bore hole against the cutter is transmitted to the flange 49 in a direction at right angles to the adjacent surface of the flange. Consequently the flange on the bearing member resists the radial thrusts which might otherwise rock the cutter 53 with respect to the axis of the spindle, thereby causing the cutter to become held against rotation. The flange 49 on the spindle 47 is provided further

with a radial surface 57 which engages the ends of the rollers 52.

The bevelled edge 56 of the roller cutter cooperates with suitable means for taking thrusts in a vertical direction. Such means comprises a bearing bushing 58 seated in notch 16 of the bit head and removably secured to the latter as by a press fit. As shown in Fig. 7, the notch 16 is of non-circular shape, and the bearing bushing is of corresponding shape to prevent rotation of the latter. The bearing bushing 58 has a flange 59 engaging the inclined wall 15 in the bit head. The flange 59 has a bevelled surface and a radial surface similar to flange 49 previously described, and the bevelled surface of the former engages the cooperating surface 56 of the cutter 53 to prevent the cutter from rocking about its spindle when an upward force is exerted on the cutter.

At the upper end of the central recess, the carrier member 14 is provided with two arcuate grooves 60 and 61 receiving the upper ends of the respective cutting disks 45. The grooves are separated by a reinforcing web 62 (see Fig. 9).

The present invention also comprises an arrangement for conducting flushing fluid from the drill stem to both the roller cutters and the disks. The cylindrical part 13 of the carrier member has a central bore 64 communicating with the bore 11 in the bit head and serving as a passage for flushing fluid. The body portion 18 of the carrier is undercut at 65 (Fig. 9) above the roller cutters and is provided with passages 66 leading from the central bore to the undercut portions, whereby flushing fluid may impinge directly upon the roller cutters. Other passages 67 lead downwardly through the body 18 to the annular grooves 60 and 61 to direct flushing fluid against the top of the disk cutters 45. In addition to the passages 66 and 67 the carrier member is provided with conduits 68 diverging from the web 62. These conduits are arranged to discharge flushing fluid between the disk cutters and toward the bottom of the bore hole at the peripheral edge thereof. The relative positions of the passages 66, 67 and 68 are illustrated in Fig. 8.

The operation of the invention will be understood from the above description. The disk cutters gouge out the earth formation at the center of the hole, while the side roller cutters maintain the gauge of the hole and relieve the disks from wear. Convenient removal of cuttings is provided by the dimensions of the bit head and by the passages for directing flushing fluid against each of the cutters and also directly upon the bottom of the hole.

When it is desired to replace any or all of the cutters, the bolts 25 may be removed and the entire cutter unit withdrawn downwardly from the bit head.

While the various features of the invention cooperate with each other, some of them may be used independently. For example, the means for supporting the disk cutters against thrusts may be employed to advantage in disk bits which do not embody roller cutters.

The illustrative embodiment of the invention incorporates certain features claimed in applicant's copending applications. The bearing bushing 58 is covered per se, and in combination with the bit head and cutter unit structure, in application Serial No. 646,628, filed December 10, 1932. The carrier member 14, its means of attachment to the bit head, and its arrangement for supporting the inner ends of upwardly diverging spindles and for supporting a cutter within a recess in the carrier member, are claimed broadly in application Serial No. 593,650, filed February 17, 1932. They are also claimed, more specifically, in application Serial No. 608,295, filed April 29, 1932, which relates to a structure of this character in which the outer ends of the upwardly diverging spindles are received within downwardly open notches in the bit head.

What is claimed is:

1. A roller bit comprising a bit head, a carrier member seated in the bit head, said carrier having exteriorly thereof side roller cutters, the axes of which project toward the bit head axis, and disk cutters in a slot passing through said carrier and opening downwardly, the axes of said disk cutters being offset laterally from a vertical plane through the bit head axis, all cutter axes being in parallel planes.

2. In combination, a bit head, a carrier secured thereto, roller cutters mounted exteriorly of said carrier, and a disk cutter unit mounted in a recess in the lower end of said carrier, all cutter axes being in parallel planes.

3. A carrier member mounting side roller cutters inclined to the axis of the said member, disk cutters between the side roller cutters, and carrier walls between roller and disk cutters, all cutter axes being in parallel planes.

4. A drill bit comprising a head and a removable body member having a recess at its lower end, one or more disk cutters disposed within said recess and supported by the body, and a plurality of roller cutters mounted upon spindles at the outside of the body member, said roller cutters being supported on inclined axes and cutting on the bottom of the bore hole, all cutter axes being in parallel planes.

5. A disk bit comprising a body or carrier member having at its lower end two spaced spindle supporting portions, the inner walls of which define a recess therebetween, one or more disk cutter units mounted in said recess, the outer faces of said spindle supporting portions diverging downwardly and having spindles projecting outwardly therefrom supporting roller cutters, said recess being centrally disposed with respect to the bit axis, all cutters being positioned side by side in spaced relation.

6. A disk bit comprising a body or carrier member having at its lower end two spaced spindle supporting portions, the inner walls of which define a recess therebetween, one or more cutter units mounted in said recess, the outer faces of said spindle supporting portions diverging downwardly and having spindles projecting outwardly therefrom supporting roller cutters, said recess being centrally disposed with respect to the bit axis and said spindles having axes in the same plane and at the same angle of inclination, all cutters being positioned side by side in spaced relation.

7. A carrier mounting rolling disk cutters in a recess on axes offset laterally from a radial plane, and having exteriorly thereof inclined sides, and roller cutters mounted thereon, for cutting on the bottom of the bore hole.

8. A carrier according to claim 7 having a web projecting downwardly between the disks and a fluid passageway in said web.

9. A drill bit comprising a body or carrier member having a recess in its lower end, said recess being defined by vertical walls in which are formed seats, a cutter unit comprising a spindle with a cutter rotatable thereon, the axis of which is offset from the bit axis, said spindle and cutter

being insertable together longitudinally of the bit head into said recess, said spindle being supported by means fitting into said seats.

10. A drill bit comprising a body or carrier member having at its lower end two spaced spindle supporting portions, the inner walls of which define a recess, said walls being imperforate and having means for supporting a cutter spindle in said recess, on an axis offset from the bit axis, and inclined spindles projecting outwardly from the outer walls of said portions.

11. A disk bit comprising a body member, a pair of spindles supported in said body member and having horizontal axes and adapted to support disk cutters in parallel planes, a spacer member between said disks, said spacer member being supported by said spindles, and side cutters mounted on inclined spindles for cutting on the bottom of the bore hole.

12. A disk bit comprising a body member having a recess at its lower end, a pair of spindles in said recess having horizontal axes and adapted to support disk cutters in parallel planes, a spacer member between said disks, said spacer member being supported by said spindles, and side cutters mounted on inclined spindles for cutting on the bottom of the bore hole.

13. A disk cutter unit comprising disk cutters, spindles therefor, a spacer member between the disks, and thrust receiving members adapted to be held in operating position by the walls of a cutter recess, the thrust receiving members, spindles and spacer member being interfitting to be handled as a unit, and so mounted between inclined side cutters operating on the bottom of the bore hole that the disks do not contact the side of the bore hole.

14. A disk cutter unit according to claim 13 in combination with a carrier member having a recess for receiving said disk cutter unit and having seat recesses in the walls of the first-named recess.

15. A disk cutter unit according to claim 13 the axes of the disk cutters being staggered.

16. In an earth boring drill, a head and a body member, a pair of cutter spindles inclined to the axis of the drill and supported by said body member, a cutter unit supported by the body member and positioned between the inclined spindles, said cutter unit comprising a pair of spindles having their axes out of line, each of the last-mentioned spindles having mounted thereon a set of roller bearings and a disk cutter revolvable on said bearings, and a spacer member engaging the adjacent ends of the last-mentioned spindles and positioned between the disk cutters to maintain them in spaced relation, all spindle axes being in parallel planes.

17. In a well drilling bit, a carrier member having exteriorly thereof a socket adapted to receive a roller cutter spindle and having a downwardly open recess in the lower face of the carrier member, said recess being defined by two vertical walls on opposite sides of the bit axis, the vertical walls of the recess having seat recesses therein, and spindles supported by means within the respective seat recesses, the last-mentioned spindles having parallel axes and being adapted to support roller cutters.

18. In an earth boring bit, a carrier member having exteriorly thereof spindles projecting upwardly and outwardly from the carrier member, a roller cutter on each of the spindles, said carrier member having at its lower end a downwardly open recess, a pair of spindles supported within the recess, a plurality of cutters rotatably mounted on said last-mentioned spindles, the latter having their respective axes out of line and on opposite sides of the bit axis whereby said last-mentioned cutters are arranged to produce a scraping action on the bottom of the bore hole.

19. A drill bit comprising a body or carrier member having a recess in its lower end, a cutter assembly supported by said body within said recess and comprising a spindle having a cutter mounted thereon, the axis of said cutter being displaced a substantial distance from the bit axis whereby said cutter produces a scraping action on the bottom of the bore hole, said cutter assembly being insertable into and removable from said recess as a unit and being supported by the walls of the recess, inclined spindles projecting outwardly from the sides of the carrier member, and cutters mounted on said last-mentioned spindles for operating on the bottom of the hole.

20. A drill bit comprising a body or carrier member having at its lower end two spaced spindle supporting portions, the inner walls of which define a recess, said walls having seat recesses therein, a pair of spindles having flanges formed thereon which fit into said seat recesses for supporting said pair of spindles, each of the latter having a cutter mounted thereon, said cutters having axes displaced a substantial distance from the bit axis whereby said cutters produce a scraping action at the bottom of the hole.

21. A carrier having an upper body portion from which a lug projects laterally, and having an enlargement from which a roller cutter support projects downwardly, a cutter supported by a spindle mounted in a recess in the exterior face of said support and end thrust receiving means at the inner face of said support for mounting a roller cutter on a spindle, all cutters mounted on said carrier contacting the bottom of the bore hole, and all cutters having axes positioned in parallel planes.

22. In combination a bit head, side cutters mounted on inclined spindles on said bit head for operating on the bottom of the hole, two disk cutters mounted intermediate the side cutters, all cutter axes being in parallel planes, a spacer member between the disk cutters and engaging the inside face of one of the disk cutters, an end thrust receiving member engaging the spacer member and the outside face of said last-mentioned disk cutter, said last-named member carrying a spindle portion on which the last-mentioned disk cutter is mounted.

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